

NAL PROPOSAL No. 0115

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Search for Long Lived Particles ( $\tau \gtrsim 0.1$  m sec)

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# NAL Proposal

## I. Search for Long lived ( $\tau \gtrsim$ 0.1 m sec) Particles

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### Abstract:

This "Nook and Cranny" experiment is designed to look for particles of  $\sim$  millisecond lifetime (or of lifetimes longer than the 20 to 60  $\mu$  sec external beam time structure.) If their decay products have a range of a few gms/cm<sup>2</sup> they could be detected with a small four-counter telescope that is gated on a few milliseconds after a short time-structured proton beam strikes the beam dump. Transverse holes drilled at various longitudinal positions in the beam dump would allow the decay products to escape and be detected. Their time distribution,  $e^{-t/\tau}$  would signify their existence.

## II Physics Justification

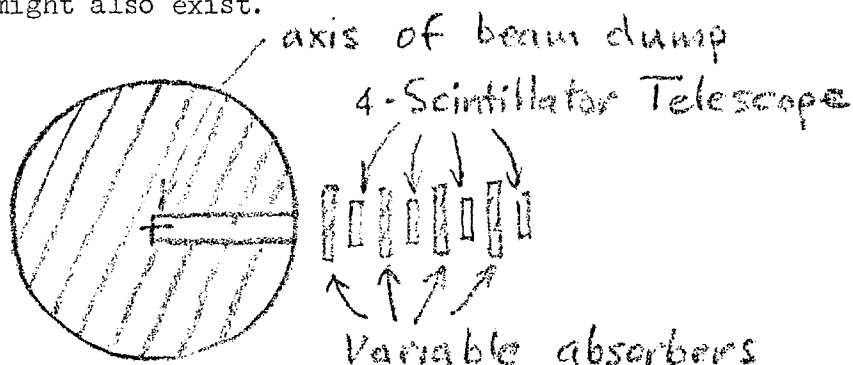
Alvarez, Crawford, and I did a similar experiment when the Bevatron first turned on. It was motivated by a cloud chamber event that was reported to have had two tracks of differing apparent age. The physics justification is simply one of curiosity as to whether long lived particles might exist.

## III. Experimental Arrangements and Apparatus

The experimental equipment namely, a four counter telescope, can literally be carried under one's arm and placed at various longitudinal

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positions alongside one of the beam dumps. Transverse holes drilled to the axis of the dump and suitably located longitudinally would allow the decay particles to escape and be detected. These holes might be the ones provided for the muon-shield monitoring of the wide band neutrino beam. Other possibilities might also exist.



Cross section view of the beam dump.

One of the reasons why these particles might not have been seen at existing accelerators is because of their large mass. One, therefore, asks about the expected behavior of a massive particle, created with low momentum in the center of mass system, as it passes through matter. Whether it is weakly interacting or strongly interacting it is likely to proceed deeply into any absorbing medium. Knowledge of the behavior of high energy hadron jets in cosmic rays confirms the difficulty in bringing energetic nucleons to rest by interaction or ionization. If they are massive they are not likely to be found near "thin targets." However, one should not exclude the possibility of their being light. Consequently, one should point the telescope at "thin" targets as well. The axis of the telescope should always be oriented in such a way as to minimize the possibility of an energetic muon originating from the main ring accelerator and passing through the telescope. The same precaution should be used for cosmic rays. The telescope should be shielded from cosmic ray air showers.

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It is assumed that there will be no "after pulsing" of the circulating beam of the main ring into the external channel. If there is there are ways of dealing with that problem which I won't discuss here. The electronics consists of a high voltage supply, discriminators, a coincidence circuit, some variable gates and some scalers; <sup>all</sup> of which exists.

#### IV. Scheduling

I had thought of doing this experiment in conjunction with some of the early measurements of the muon flux in the shield of the neutrino beam. I will be in residence at NAL from April 1971 through September 1971 and would be able to make the measurements in a completely parasitic manner if the external proton beam were being dumped at that time.

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February 22, 1971

Dr. R. R. Wilson  
Director, NAL  
P.O. Box 500  
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Dear Bob:

Your recent letter of 10 February 71 to NAL Users caught me with a "Nook and Cranny" experiment in my hip pocket. I have been reluctant to formally propose it because it is so trivial to do. It is similar to one that Alvarez, Crawford and I conducted when the Bevatron first came on. The idea was to search for particles with  $\sim$  millisecond meanlives. At the time, it was motivated by a cloud chamber picture showing an event that had two tracks of apparently differing ages. We called it the "Delayed Figment" experiment. It consisted of a small 4-counter telescope with variable thickness material between each scintillator. The proton beam was pulsed onto a nearby target. A gate delayed by some tens of milliseconds (after the proton beam was all gone) was opened and we proceeded to look for the resulting 4-fold coincidence decay curve produced by the "figment's" decay products. We never saw any 4-fold coincidences. We did, however, see some 2-fold ones when the absorber was removed from between two of the counters. It turned out to be the energetic (17 MeV) positrons from the induced  $N^{12}$  in the plastic scintillator that produced pulses in the two adjacent counters.

It should be repeated at NAL. If such a particle has not been seen at existing accelerators it could be because of its high mass. Therefore, one should ask what happens to massive quasi-stable particles as they pass through matter. From my study of the nucleon cascading phenomena in thick targets ("Targets for the Neutrino Beam; Concepts" TM 218 15 February 1970,) I think it likely to find these massive particles between the end of the nucleon cascade region and the end of the beam dumps. In any event since the apparatus can be literally carried under one's arm one can look in lots of places.

I have talked casually about this to Jimmy Walker and to Al Mashke. They seemed to be logical people who might take an early look for "Figments." They are very busy people and I would enjoy working

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with them if they had the time. In case you feel that this "experiment" should go before the Program Advisory Committee I have enclosed it as an official proposal -- but as I said earlier I do it with some hesitation. I look forward to seeing you during the 11-12 March 71 Workshop.

Sincerely yours,



M. Lynn Stevenson

MLS:am  
encl.

CC: F.T. Cole  
J. Walker  
A. Mashke